

What is claimed is:

1 1. A method of transmitting data over a communica-
2 tions network, comprising the steps of:

3 multicasting content in a first transmission over a
4 data network from a sender to a multicast group compris-
5 ing a plurality of receivers;

6 in each of said receivers concurrently performing
7 the steps of:

8 detecting a missing portion of said content;

9 and

10 responsive to said step of detecting, delaying
11 for a random interval ;

12 thereafter transmitting no more than one negative
13 acknowledgement in a second transmission from one of said
14 receivers to said sender; and

15 responsive to said negative acknowledgement multi-
16 casting said missing portion in a third transmission from
17 one of said sender and another of said receivers to said
18 multicast group.

1 2. The method according to claim 1, wherein said ran-
2 dom interval has a lower limit given by

$$LL = (a_1 t_{min}) \times b$$

4 wherein \times is a multiplication operator, a_1 is a propor-
5 tionality constant, t_{min} is a minimal round trip transmis-
6 sion time between said sender and a respective one of

7 said receivers, and b is a size of a largest packet of
8 said missing portion.

1 3. The method according to claim 1, wherein said ran-
2 dom interval has an upper limit given by

3
$$UL = (a_1 t_{\min}) \times b$$

4 wherein x is a multiplication operator, a_2 is a propor-
5 tionality constant, t_{\max} is a maximum round trip transmis-
6 sion time between said sender and a respective one of
7 said receivers, and b is a size of a largest packet of
8 said missing portion.

1 4. The method according to claim 1, further compris-
2 ing the step of

3 determining a current quantity of traffic on said
4 data network;

5 wherein said second transmission is sent when said
6 current quantity is less than a predetermined value.

1 5. The method according to claim 1, wherein said ran-
2 dom interval is a shortest said random interval of said
3 receivers.

1 6. The method according to claim 1, wherein said
2 third transmission is sent by said sender.

1 7. The method according to claim 1, wherein said
2 third transmission is sent by one of said receivers.

1 8. A computer software product, comprising a com-
2 puter-readable medium in which computer program instruc-
3 tions are stored, which instructions, when read by at
4 least one computer, cause said at least one computer to
5 execute a method of transmitting data over a data net-
6 work, comprising the steps of:

7 multicasting content in a first transmission over
8 said data network from a sender to a multicast group com-
9 prising a plurality of receivers;

10 in each of said receivers concurrently performing
11 the steps of:

12 detecting a missing portion of said content;

13 determining a random interval; and

14 responsive to said step of detecting, delaying
15 for said random interval ;

16 thereafter transmitting no more than one negative
17 acknowledgement in a second transmission from one of said
18 receivers to said sender; and

19 responsive to said negative acknowledgement multi-
20 casting said missing portion in a third transmission from
21 one of said sender and another of said receivers to said
22 multicast group.

1 9. The computer software product according to
2 claim 8, wherein said random interval has a lower limit
3 given by

$$LL = (a_1 t_{\min}) \times b$$

4
5 wherein x is a multiplication operator, a_1 is a propor-
6 tionality constant, t_{\min} is a minimal round trip transmis-
7 sion time between said sender and a respective one of
8 said receivers, and b is a size of a largest packet of
9 said missing portion.

1 10. The computer software product according to
2 claim 8, wherein said random interval has an upper limit
3 given by

$$UL = (a_1 t_{\min}) \times b$$

4
5 wherein x is a multiplication operator, a_2 is a propor-
6 tionality constant, t_{\max} is a maximum round trip transmis-
7 sion time between said sender and a respective one of
8 said receivers, and b is a size of a largest packet of
9 said missing portion.

1 11. The computer software product according to
2 claim 8, further comprising the step of
3 determining a current quantity of traffic on said
4 data network;

5 wherein said second transmission is sent when said
6 current quantity is less than a predetermined value.

1 12. The computer software product according to
2 claim 8, wherein said random interval is a shortest said
3 random interval of said receivers.

1 13. The computer software product according to
2 claim 8, wherein said third transmission is sent by said
3 sender.

1 14. The computer software product according to
2 claim 8, wherein said third transmission is sent by one
3 of said receivers.

1 15. A computer system, comprising:
2 a first computer;
3 a second computer interconnected in a data network
4 with said first computer, said first computer and said
5 second computer receiving multicast content in a first
6 transmission via said data network from a content server;
7 wherein said first computer and said second computer
8 have program instructions stored therein, which instruc-
9 tions cause said first computer and said second computer
10 to concurrently execute a method of transmitting data
11 over a communications network, comprising the steps of:
12 detecting a missing portion of said content;
13 determining random intervals, wherein a first random
14 interval of said first computer is shorter than a second
15 random interval of said second computer; and

16 responsive to said step of detecting, said first
17 computer delaying for said first random interval, and
18 said second computer delaying for said second random in-
19 terval; and

20 thereafter said first computer transmitting a first
21 negative acknowledgement in a second transmission to said
22 content server;

23 said content server resending said first negative
24 acknowledgement to said second computer, wherein in an
25 event that said second computer has not received said
26 missing portion, said second computer suppresses a second
27 negative acknowledgement therefor; and

28 receiving said missing portion in a third transmis-
29 sion from said content server.

1 16. The computer system according to claim 15,
2 wherein said random intervals each have a lower limit
3 given by

4
$$LL = (a_1 t_{\min}) \times b$$

5 wherein x is a multiplication operator, a_1 is a propor-
6 tionality constant, t_{\min} is a minimal round trip transmis-
7 sion time between said content server and a respective
8 one of said first computer and said second computer, and
9 b is a size of a largest packet of said missing portion.

1 17. The computer system according to claim 15,
2 wherein said random intervals each have an upper limit
3 given by

4
$$UL = (a_1 t_{\min}) \times b$$

5 wherein x is a multiplication operator, a_2 is a propor-
6 tionality constant, t_{\max} is a maximum round trip transmis-
7 sion time between said content server and a respective
8 one of said first computer and said second computer, and
9 b is a size of a largest packet of said missing portion.

1 18. The computer system according to claim 15,
2 wherein said first computer further performs the step of
3 determining a current quantity of traffic on said
4 data network;

5 wherein said second transmission is sent when said
6 current quantity is less than a predetermined value.

1 19. The computer system according to claim 15,
2 wherein said third transmission is sent by said content
3 server.

1 20. The computer system according to claim 15,
2 wherein said third transmission is sent by said second
3 computer.